

WHAT IS CLAIMED IS:

- 1 1. A refrigeration system for providing cooling to a refrigeration
2 device, comprising:
 - 3 a first cooling system having a refrigerant configured to
4 communicate with a heat exchanger to provide a primary cooling source;
 - 5 a second cooling system having a coolant configured to be
6 cooled by the primary cooling source and circulated to the refrigeration
7 device;
 - 8 a third cooling system configured to provide an auxiliary cooling
9 source to the coolant;
 - 10 so that a pressure of the coolant does not exceed a
11 predetermined pressure when the primary cooling source is unavailable.
- 1 2. The refrigeration system of Claim 1 wherein the heat exchanger
2 device is configured to at least partially condense the coolant.
- 1 3. The refrigeration system of Claim 1 wherein the third cooling
2 system is a standby cooling system having a standby heat exchanger
3 configured to condense at least a portion of the coolant.
- 1 4. The refrigeration system of Claim 3 wherein the standby cooling
2 system further comprises a backup power supply.
- 1 5. The refrigeration system of Claim 3 further comprising a
2 separator device configured to receive the coolant from the refrigeration
3 device and direct the coolant in a vapor state to the heat exchange device and
4 direct the coolant in a liquid state to the refrigeration device.
- 1 6. The refrigeration system of Claim 5 wherein the standby heat
2 exchanger and the separator are integrated as an assembly.

1 7. The refrigeration system of Claim 5 wherein the standby heat
2 exchanger and the separator and the heat exchanger device are integrated as
3 an assembly.

1 8. The refrigeration system of Claim 1 wherein the first cooling
2 system is a direct expansion primary refrigeration system.

1 9. The refrigeration system of Claim 1 wherein the coolant is
2 carbon dioxide.

1 10. The refrigeration system of Claim 1 wherein the coolant is
2 circulated to the refrigeration device by a pump.

1 11. The refrigeration system of Claim 10 wherein the pump is a
2 variable speed pump controlled by a superheat condition of the coolant
3 returning from the refrigeration device.

1 12. The refrigeration system of Claim 1 wherein the coolant is
2 circulated to the refrigeration device by natural circulation.

1 13. The refrigeration system of Claim 1 further comprising a
2 subcooler device communicating with the first cooling system and configured
3 to condense at least a portion of the coolant circulated to the refrigeration
4 device.

1 14. The refrigeration system of Claim 1 wherein the second cooling
2 system further comprises a charging system.

1 15. The refrigeration system of Claim 1 wherein the heat exchanger
2 device is located at an elevated position.

1 16. The refrigeration system of Claim 1 wherein the auxiliary cooling
2 source has a heat removal capability that is less than a heat removal
3 capability of the primary cooling source.

1 17. The refrigeration system of Claim 10 wherein the operation of
2 the pump is stopped when operation of the third cooling system is initiated.

1 18. A refrigeration system, comprising:
2 a primary cooling system configured to circulate a refrigerant to
3 a heat exchanger;
4 a secondary cooling system configured to circulate a coolant to
5 the heat exchanger and at least one refrigeration device;
6 a separator configured to direct a vapor portion of the coolant to
7 the heat exchanger and a liquid portion of the coolant to the refrigeration
8 device;
9 a third cooling system configured to cool a vapor portion of the
10 coolant from the secondary cooling system.

1 19. The refrigeration system of Claim 18 wherein the coolant
2 comprises a compound that is found in the atmosphere.

1 20. The refrigeration system of Claim 18 wherein the coolant
2 comprises carbon dioxide.

1 21. The refrigeration system of Claim 18 wherein the coolant
2 comprises a carbon dioxide blend.

1 22. The refrigeration system of Claim 18 wherein the third cooling
2 system is configured to cool at least a portion of the coolant when the primary
3 cooling system is incapable of maintaining a temperature of the coolant below
4 a predetermined temperature.

1 23. The refrigeration system of Claim 18 wherein the refrigerant
2 comprises a direct expansion refrigerant.

1 24. The refrigeration system of Claim 18 wherein the refrigeration
2 device is a low temperature device.

1 25. The refrigeration system of Claim 18 wherein the refrigeration
2 device is a medium temperature device.

1 26. The refrigeration system of Claim 18 wherein the refrigeration
2 device is a plurality of refrigeration devices and further comprising at least one
3 flow control device configured to regulate a flow of the coolant to the one or
4 more of the plurality of refrigeration devices.

1 27. The refrigeration system of Claim 18 wherein the refrigeration
2 device comprises a cooling interface configured to receive the coolant to
3 provide cooling to a space within the refrigeration device.

1 28. The refrigeration system of Claim 27 wherein the cooling
2 interface comprises a valve on an outlet of the cooling interface configured to
3 permit the coolant to expand toward an inlet of the cooling interface when the
4 valve is closed so that a liquid portion of the coolant is removed from the
5 cooling interface prior to a defrost operation.

1 29. The refrigeration system of Claim 18 wherein the secondary
2 cooling system comprises at least one pressure relief device.

1 30. The refrigeration system of Claim 29 wherein the pressure relief
2 device comprises a relief valve.

1 31. The refrigeration system of Claim 30 wherein a discharge of the
2 coolant from the relief valve is configured to be returned to the secondary
3 cooling system.

1 32. The refrigeration system of Claim 31 wherein the relief valve is
2 located proximate an outlet of the refrigeration device and the discharge of the
3 coolant is directed to a coolant return line from the refrigeration device.

1 33. The refrigeration system of Claim 18 wherein the separator is
2 oriented in a substantially horizontal configuration.

1 34. The refrigeration system of Claim 18 wherein the third cooling
2 system comprises one or more components of the primary cooling system.

1 35. The refrigeration system of Claim 18 wherein the third cooling
2 system comprises at least a portion of the primary cooling system and a
3 generator.

1 36. A refrigeration system, comprising:
2 a primary cooling system configured to provide a first source of
3 cooling to a coolant;
4 a standby cooling system configured to provide a second source
5 of cooling to the coolant;
6 a secondary cooling system configured to circulate the coolant
7 to at least one refrigeration device and to be cooled by the first source of
8 cooling when the first source of cooling is operational and to be cooled by the
9 second source of cooling when the first source of cooling is not operational;
10 so that the temperature of the coolant does not exceed a
11 predetermined temperature.

1 37. The refrigeration system of Claim 36 wherein the coolant
2 comprises carbon dioxide.

1 38. The refrigeration system of Claim 36 wherein the primary
2 cooling system comprises a first heat exchanger device configured to
3 condense at least a portion of the coolant.

1 39. The refrigeration system of Claim 38 wherein the secondary
2 cooling system comprises a separator device configured to receive the
3 coolant from the refrigeration device and direct a vapor portion of the coolant
4 to the first heat exchanger and direct a liquid portion of the coolant to the
5 refrigeration device.

1 40. The refrigeration system of Claim 39 wherein the separator
2 device is configured in a substantially horizontal orientation to increase a
3 pressure of the coolant at the refrigeration device.

1 41. The refrigeration system of Claim 39 wherein the separator
2 device and the first heat exchanger are integrated as a unit.

1 42. The refrigeration system of Claim 41 wherein the first heat
2 exchanger is at least one tube-coil disposed within the separator.

1 43. The refrigeration system of Claim 41 wherein the first heat
2 exchanger is at least one plate type heat exchanger.

1 44. The refrigeration system of Claim 41 wherein the first heat
2 exchanger is a plurality of tube-coils and comprises a distributor configured to
3 interface between a coolant supply line and the plurality of tube-coils.

1 45. The refrigeration system of Claim 36 wherein the standby
2 cooling system comprises a power source configured to operate the standby
3 cooling system independent of the primary cooling system.

1 46. The refrigeration system of Claim 39 wherein the standby
2 cooling system comprises a second heat exchanger.

1 47. The refrigeration system of Claim 46 wherein the separator
2 device and the second heat exchanger are combined as an assembled unit.

1 48. The refrigeration system of Claim 47 wherein the second heat
2 exchanger is disposed within an upper portion of the separator device.

1 49. The refrigeration system of Claim 39 wherein the separator
2 device and the first heat exchanger and the second heat exchanger are
3 configured as an assembly.

1 50. The refrigeration system of Claim 36 wherein the standby
2 cooling system comprises at least one component of the primary cooling
3 system.

1 51. The refrigeration system of Claim 50 wherein the standby
2 cooling system and the primary cooling system are configured to interface
3 with a common heat exchanger.

1 52. The refrigeration system of Claim 36 wherein the secondary
2 cooling system comprises a coolant flow device configured for variable speed
3 operation.

1 53. The refrigeration system of Claim 52 wherein the coolant flow
2 device is a pump.

1 54. The refrigeration system of Claim 52 wherein the variable speed
2 operation is configured for control in response to a signal representative of a
3 temperature of the coolant.

1 55. The refrigeration system of Claim 36 wherein the secondary
2 cooling system includes at least one over-pressure protection device
3 configured to maintain a pressure of the coolant below a predetermined
4 pressure.

1 56. The refrigeration system of Claim 55 wherein the over-pressure
2 protection device is a relief valve configured to direct a discharge of coolant to
3 another location within the secondary cooling system.

1 57. The refrigeration system of Claim 36 wherein the refrigeration
2 device is at least one of a refrigerator, a freezer, a cold storage room, a walk-
3 in cooler, a reach-in cooler, an open display case, and a closed display case.

1 58. The refrigeration system of Claim 36 further comprising a first
2 coolant line configured to supply the coolant to the refrigeration device and a
3 second coolant line configured to return the coolant from the refrigeration
4 device, wherein the first coolant line is routed at least partially within the
5 second coolant line.

1 59. A method of providing cooling to at least one cooling device,
2 comprising:

3 circulating a refrigerant to a heat exchanger;
4 circulating a coolant to the heat exchanger;
5 routing the coolant to a separator;
6 directing a vapor portion of the coolant to the heat exchanger;
7 directing a liquid portion of the coolant to the cooling device; and
8 directing the coolant from the cooling device to the separator.

1 60. The method of Claim 59 further comprising the step of directing
2 the vapor portion of the coolant to a pressure control device when a pressure
3 of the coolant exceeds a predetermined pressure.

1 61. The method of Claim 59 wherein the pressure control device is a
2 condenser device configured to provide a source of cooling from an auxiliary
3 cooling system.

1 62. The method of Claim 60 wherein the pressure control device is a
2 vessel having a volume sufficient to accommodate warming of the coolant to
3 an ambient temperature.

1 63. The method of Claim 59 wherein the coolant comprises a
2 compound found in the atmosphere.

1 64. The method of Claim 63 wherein the compound comprises
2 carbon dioxide.

1 65. The method of Claim 59 further comprising the step of providing
2 the heat exchanger and the separator as an integrated assembly.

1 66. The method of Claim 59 further comprising the step of providing
2 the heat exchanger and the separator and the condenser device as an
3 integrated assembly.

1 67. The method of Claim 59 further comprising the step of providing
2 a coolant flow device configured for variable speed control.

1 68. The method of Claim 67 further comprising the step of providing
2 a signal representative of a temperature of the coolant to regulate the variable
3 speed control and wherein the coolant flow device comprises a pump.

1 69. In a refrigeration system of a type used with a refrigeration
2 device such as a temperature controlled case used for storage and display of
3 foods for commercial sale having a primary cooling system configured to
4 provide a primary fluid as a refrigerant and a secondary cooling system
5 coupled to the primary cooling system configured to provide a secondary fluid
6 as a coolant, the improvement comprising the secondary cooling system
7 comprising a vessel configured to provide a volume to accommodate an
8 increase in pressure of the coolant that occurs when the temperature of the
9 coolant is increased.

1 70. The refrigeration system of Claim 69 wherein the coolant
2 comprises a compound available from the atmosphere.

1 71. The refrigeration system of Claim 69 wherein the compound
2 comprises carbon dioxide.

1 72. The refrigeration system of Claim 69 wherein the primary
2 cooling system comprises a heat exchanger disposed at an elevated location.

1 73. The refrigeration system of Claim 72 wherein the coolant is
2 circulated to a cooling interface of the refrigeration device and the cooling
3 interface is disposed beneath the heat exchanger.

1 74. The refrigeration system of Claim 69 wherein the coolant is
2 circulated within the secondary cooling system by natural circulation.

1 75. The refrigeration system of Claim 69 wherein the coolant is
2 circulated within the secondary cooling system by a pump.

1 76. The refrigeration system of Claim 69 wherein the secondary
2 cooling system comprises a separator device configured to direct a vapor
3 portion of the coolant to a heat exchange device in communication with the
4 primary cooling system and to direct a liquid portion of the coolant to a
5 refrigeration device.

1 77. The refrigeration system of Claim 76 wherein the separator
2 device is configured to maximize the height of a liquid level of coolant.

1 78. The refrigeration system of Claim 69 wherein the vessel has a
2 volume sufficient to prevent over-pressurization of the secondary cooling
3 system when the temperature of the coolant is approximately an ambient
4 temperature.

1 79. A refrigeration system, comprising:
2 a primary cooling system configured to provide a source of
3 cooling;
4 a secondary cooling system configured to circulate a coolant to
5 be cooled by the source of cooling, the coolant being in one of a liquid state, a
6 vapor state and a liquid-vapor state;
7 a volume inherent in the secondary cooling system and
8 configured to accommodate expansion of the coolant in the event that the
9 source of cooling is insufficient to maintain the temperature of the coolant
10 below a predetermined temperature.

1 80. The refrigeration system of Claim 79 wherein the coolant
2 comprises a naturally occurring compound.

1 81. The refrigeration system of Claim 79 wherein the compound
2 comprises carbon dioxide.

1 82. The refrigeration system of Claim 79 wherein the volume
2 inherent in the secondary system includes a vessel.

1 83. The refrigeration system of Claim 79 wherein the volume
2 inherent in the secondary system includes at least one of a piping volume, a
3 separator volume, a cooling interface volume and a heat exchanger volume.

1 84. The refrigeration system of Claim 79 wherein the volume
2 inherent in the secondary cooling system is sufficient to prevent over-
3 pressurization of the secondary cooling system when the temperature of the
4 coolant is approximately an ambient temperature.

1 85. The refrigeration system of Claim 79 wherein the refrigeration
2 device is one of a refrigerator, a freezer, a cold storage room, a walk-in
3 freezer or a reach-in cooler.